San Mateo Smart Corridor System
Systems Engineering Management Plan (SEMP)
Document #10000.007

C/CAG

July 31, 2013

J13-1737

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1.0 Purpose of the Document

This document presents the San Mateo County Smart Corridor Systems Engineering Management Plan (SEMP). The purpose of this document is to:

- Identify the stakeholders and their roles/responsibilities
- Document the process to be followed in developing, installing, operating and maintaining the system
- Specify the documentation requirements for the system
- Document the management controls that will be used to manage the project

In 2009, a SEMP was developed to serve as a guidebook for the stakeholders throughout the course of the project. As part of the System Integrator support project, Iteris is tasked to update the SEMP in accordance with FHWA guidelines. Iteris reviewed the September 2009 version document and compared it to FHWA's current SEMP guidelines, version 3.0 dated November 2009. This version of the SEMP incorporates necessary changes to adhere to the FHWA's current guidelines.

In later stages of the project, supplementary plans as appendices to the SEMP document will be prepared including:

- Interface Control Plan
- Verification Plan
- Verification Procedures
- Deployment Plan
- Training Plan

2.0 Scope of Project

The mitigation of impacts of non-recurring traffic congestion on local streets in San Mateo County due to major freeway incidents on US-101 was identified as a high-priority project in the Smart Corridor Program. Accordingly, the City/County Association of Governments (C/CAG), in cooperation with the San Mateo County Transportation Authority (SMCTA), the Metropolitan Transportation Commission (MTC), the California Department of Transportation (Caltrans) District 4 and the cities of San Carlos, Millbrae, East Palo Alto, San Bruno, San Mateo, Redwood City, Belmont, Burlingame, Atherton and Menlo Park, initiated an effort to develop a countywide traffic management system, the San Mateo Smart Corridor Program. The overall Smart Corridor Program (Program) includes the installation of the following ITS elements:

- Directional signs (trailblazer and turn prohibition) to direct traffic;
- Fixed and pan-tilt-zoom closed-circuit television (CCTV) cameras at intersections and midblock locations to monitor traffic congestion and evaluate length of traffic queues;
- Communications to provide interconnect between local agency traffic signals on local streets and State operated traffic signals on State routes;
- Upgraded traffic signal controllers and/or cabinets and traffic signal operation software systems to provide increased traffic flow during incident and non-incident conditions;
- Arterial dynamic message signs (ADMS) to inform motorists of traffic conditions;
- Center-to-center communications between all local agencies and the Caltrans District 4 Transportation Management Center (D4TMC) to increase sharing of data and video during incident conditions; and
- Vehicle detector stations (VDS) on non-freeway state routes (El Camino Real) and local streets at mid-block locations for better monitoring of traffic during incident conditions.

The Program is comprised of ITS field elements managed and shared by the local agency stakeholders and Caltrans operations staff for improved traffic management capabilities between the freeway and arterial corridors. A critical component of this system is the communication infrastructure which consists of fiber optic cable, Ethernet hardware and ITS device controllers. All ITS field devices are connected and controlled at both the local Traffic Management Center (TMC) and the Caltrans TMC through the communication infrastructure. Each local agency in the program has a “virtual TMC”, meaning there is no centralized location where operations management occurs. Rather, local agency staff manages their systems from their own workspaces (offices, cubicles, etc.). By contrast, Caltrans District 4 has a large TMC facility dedicated to managing the freeways within the entire nine-county Bay Area. During normal working hours, each agency operates its own system with Caltrans assuming operations for the entire system during incidents and off-hours.

2.1 Project Background

C/CAG and SMCTA, in conjunction with Caltrans District 4, has initiated an effort to address the operation of the freeway and arterial roadway network in San Mateo County. The San Mateo County Smart Corridor Program is intended to benefit a variety of users including commuters, local traffic, and commercial vehicle and transit operators.

A Traffic Incident Management Committee (TIMC) was formed to identify and evaluate projects under the Smart Corridor Program. The TIMC is comprised of representatives of local agencies, Caltrans, California Highway Patrol (CHP), MTC, San Mateo County Office of Emergency Services (OES) as well as C/CAG and SMCTA. The TIMC focus is to increase coordination between Caltrans, CHP, local agency public safety, and local agency public works staff during freeway incidents when a significant amount of traffic is expected to exit the freeway and use local streets as an alternate.

In addition, a Steering Committee was established as the decision-making body of the Smart Corridors Program. Members include the Caltrans District 4 Chief of Operations, the MTC Director of Highway Operations, the SMCTA Program Director, the San Mateo City Public Works Director, and the C/CAG Executive Director.

The TIMC also facilitated the development of the Alternate Routes for Traffic Incident (ARTI) Guide (April 2008) to identify arterial streets that would best serve as alternative routes for moving traffic during incidents on US-101 and minimizing the impacts of diverted traffic on the local street network across multi-jurisdictional boundaries. During normal operations, each local agency will control its respective signalized intersections and have access to the CCTV cameras. During a major freeway incident on US-101, operators at the D4 TMC will implement previously developed special-event signal timing plans and activate Informational Message Signs (IMS), trailblazer signs (TBS) and arterial dynamic message signs (ADMS) along the appropriate ARTI route(s) and notify the local agencies that the management of the alternate route(s) is in effect. The ARTI Guide has subsequently been revised (June 2009) with the assistance of Caltrans staff.

The project is estimated to cost $30.71 million, with $22.37 million in construction costs, with a phased approach proposed. A Project Study Report (PSR) for this project was approved on March 28, 2008.

A Concept of Operations (ConOps) was prepared in October 2008 and updated in September 2009, with input from local agencies and Caltrans, and direction from the Federal Highway Administration (FHWA). This is an initial step in the Systems Engineering process defined by the FHWA. This document identifies the stakeholders, their roles and responsibilities, their coordination with each other, and how the system will be developed.

2.2 Goals of the Project

The goals of the project identified in the Concept of Operations have been modified as shown in **Table 1**.

Table 1 – Project Goals

Goal Area	Smart Corridors Program Goals
Traffic Incident Management	• Proactively manage traffic already diverted from the freeway to minimize impacts on local arterials, and return regional traffic back to the freeway as soon as possible by: ○ Actively managing traffic signal operations on selected routes to maximize traffic flow around a major incident and minimize delays caused by diverted freeway traffic. ○ Improving collection of current travel condition information along local arterials on the alternate routes. (Future) ○ Providing accurate and timely route guidance information about the corridors to agency transportation managers. (Future) ○ Minimizing the intrusion of freeway traffic on local streets due to major freeway incidents.
Interagency Coordination	• Provide the capability for shared control and operation of the Smart Corridors components by the agencies. • Improve sharing of resources between agencies for more unified transportation management operations across jurisdictions. • Improve communications between the agencies during major freeway incidents
Traffic Operations and Management	• Improve traffic flow within the corridor during normal operation • Share traffic information between the agencies to improve coordination and management of traffic during normal operations

2.3 Project Phasing

The complete deployment of the Smart Corridor program includes the freeway network and parallel arterials of regional significance in San Mateo County. The deployment will be completed in phases, with each subsequent phase building upon the elements of previous phases.

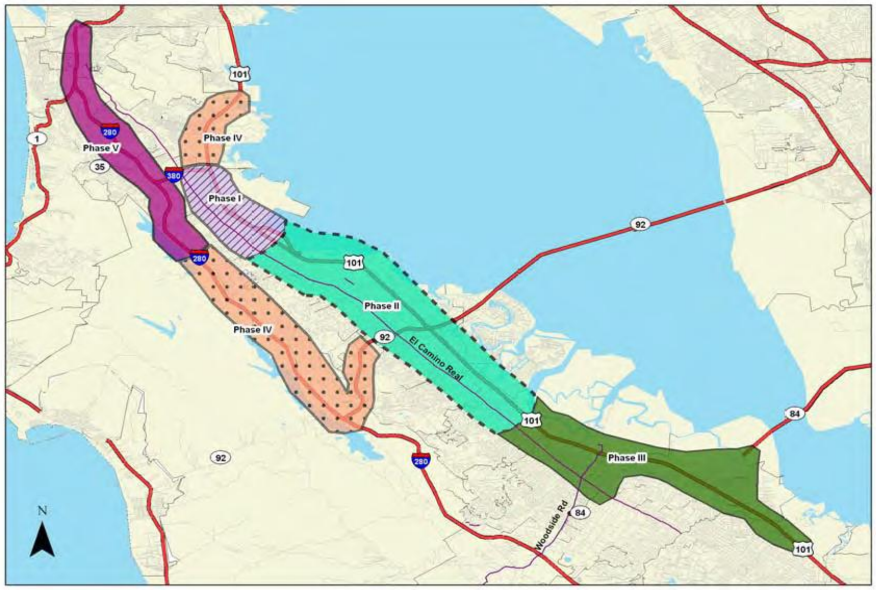

Figure 1 – Smart Corridor Project Phasing

As shown in **Figure 1**, there are three primary phases currently planned for the Smart Corridor Program. These phases include:

- Phase I – US-101 and adjacent local streets between I-380 and 3rd Avenue;
- Phase II – US-101 and adjacent local streets between 3rd Avenue and Whipple Avenue; and
- Phase III – US-101 and adjacent local streets between Holly Street and the Santa Clara County Line.

In order to implement these phases, the Smart Corridor Program was divided into the five projects noted below:

- Project #1: the San Mateo Demonstration project was a proof of concept deployment in the City of San Mateo and was completed in early 2013.
- Project #2: this project was designed as part of three separate projects, the North, South and South Extension projects and includes all elements in local agency Right-of-Way. This project is currently in construction.

- Project #3: this project was designed by Caltrans, in parallel with Project #2, to install ITS improvements on Caltrans Right-of-Way, including El Camino Real, from Whipple Avenue to I-380. This project is currently in construction.
- Project #4: this project will complete the operations planning and integrate the ITS devices that were designed and now being constructed in the other projects.
- Project #5: this project was designed by Caltrans, in parallel with Project #2, to install ITS improvements on Caltrans Right-of-Way from Whipple Avenue to the Santa Clara County line.

2.4 Stakeholder Roles

The stakeholders and their roles in this project are listed in **Table 2**.

Table 2 – Project Stakeholders and Current and Proposed Roles

Stakeholder	Current Role(s)
C/CAG	Organize stakeholders in San Mateo County and build consensus; project champion/sponsor; administrative lead.
Caltrans	Operate and maintains the freeways (US-101) and state routes (El Camino Real, SR-84, etc.). Lead the technical side of the project. Will operate the system in the event of a major incident.
SMCTA	Administers the proceeds of a county-wide half-cent sales tax (Measure A) for transportation projects; participates in project steering committee; administers consultant contracts.
CHP	Enforcement, security, and accident investigation on the freeways and state highways. Typically the incident commander.
MTC	Metropolitan Planning Organization (MPO) of the Bay Area, maintains the Regional ITS Architecture, distributes transportation funds; operates and maintains 511, the regional ATIS, and the regional center-to-center data sharing network (currently in development)
San Mateo County	Operate and maintain arterials within its jurisdiction.
San Mateo County Transit (SamTrans)	Operate bus service on the arterials and freeways.
Caltrain	Operate heavy rail commuter service and support private shuttle service

Bay Area Rapid Transit (BART)	Operate commuter rail service.
Dumbarton Express	Operate bus service on the arterials and freeways.
Local Emergency Response and Public Safety Agencies	Respond to incidents on local routes, coordinate with traffic management personnel on local and state routes, and coordinate with CHP during major incidents.
Town of Atherton	Operate and maintain arterials within its jurisdiction.
City of Belmont	Operate and maintain arterials within its jurisdiction.
City of Burlingame	Operate and maintain arterials within its jurisdiction.
City of East Palo Alto	Operate and maintain arterials within its jurisdiction.
City of Menlo Park	Operate and maintain arterials within its jurisdiction.
City of Millbrae	Operate and maintain arterials within its jurisdiction.
City of Redwood City	Operate and maintain arterials within its jurisdiction.
City of San Bruno	Operate and maintain arterials within its jurisdiction.
City of San Carlos	Operate and maintain arterials within its jurisdiction.
City of San Mateo	Operate and maintain arterials within its jurisdiction.
Contractors	Construct ITS field elements and conduct testing.
Consultants – Kimley-Horn	Prepare environmental documentation.
Consultants – Iteris and URS	Develop plans, specifications and estimates.
System Integrator – Iteris	Develop and implement system engineering process. Develop System Integration process and support the System Integration activities.
Signal System Vendor	Implement Smart Corridor signal system.
Signal Timing Consultant	Develop signal timing for all traffic signals in the Smart Corridor area.

The ARTI provides the stakeholders a guideline/process for implementing route guidance and operational strategies to manage diverted traffic on local streets, minimizing the impacts on the residents of County of San Mateo. The primary objectives of the project identified in the ARTI are:

- Proactively manage traffic on local streets that has diverted off the freeway due to a major incident on US-101 or other freeway;
- Minimize the delay that traffic experiences on local streets during major freeway incidents;
- Instrument local streets and provide the TMC operators with the tools to proactively manage traffic detoured due to an incident;

- Enhance the communications and coordination between "local agency public safety, Caltrans, CHP, and local agency public works" to create a regional approach to managing incident traffic; and
- Enable local agencies to share information and control strategies to enhance traffic management.
- Through installation of ITS equipment along the alternate routes, the stakeholders will have tools and strategies that will enable them to do the following:
- Change route guidance signs to guide incident traffic along a specific alternate route to avoid a situation where drivers seek unknown routes;
- Increase the green time along an alternate route during an incident to reduce the travel time.
- Monitor traffic on local streets;
- Share data and video between agencies to create a regional partnership to manage traffic; and
- Coordinate operations between Caltrans and local agencies during major incidents.

Caltrans has agreed to commit to active operation and control of the Smart Corridor tools by the D4 TMC operators with support from local agencies. Active operation during major freeway incidents will include implementing alternate route signage and monitoring CCTV camera images to optimize the flow of traffic along alternate routes. If necessary, it will also require modifying device parameters in response to changing conditions. The system will also require communication and coordination between agencies, adjustment of signal timing, notifications to travelers, and other operational strategies implementation along the affected portion of the corridor in an event of major freeway incident.

The segment of US-101 within the County of San Mateo is part of the National Highway System, classified as a strategic highway network route to provide defense access, continuity, and emergency capability for transporting personnel, materials, and equipment during both peace and war times.

2.5 Technical Challenges

Technical challenges to be faced on this project include:

- Coordination of signals across jurisdictional boundaries
- Sharing of control on a hierarchical basis
- Providing a communications network on already crowded local roadways
- Providing aesthetically pleasing equipment in an urban setting

- Use of a hybrid communications system
- Integration of local ITS equipment and systems into a regional traffic management center
- Future integration of the local systems into the Caltrans ATMS

3.0 Technical Planning and Control

The purpose of this section is to describe the activities and plans that will act as controls on the project's systems engineering activities.

3.1 WBS Structure

A Work Breakdown Structure (WBS) is a hierarchical structure that contains the following information:

- The identified project tasks and subtask
- The name of the task or subtask
- The allocated budget for the task or subtask (although this can be elsewhere)
- The team or organization with the authorization to give direction to the task
- The roles and responsibilities of those parties involved in the task
- The WBS structure combined with the overall project schedule will be used to track discrete project activities.
- The WBS structure and overall project schedule.

3.2 Task Deliverables

The Systems Integration process as applied to the current project will produce, at a minimum, the following documents:

- Network Design
- Physical Network drawings
- Updates to Systems Engineering Management Plan (SEMP). The System Integrator will create following plans for inclusion as appendices to the SEMP:
    - Interface Control Plan
    - Verification Plan
    - Verification Procedures
    - Deployment Plan

    - Training Plan
    - System Test Plan
    - Configuration Management Plan
    - Integration Management Plan
    - Operations & Maintenance Plan
- Updates to Concept of Operations (ConOps)
- Updates to Traceability Matrix

Documents will be circulated to appropriate parties and agencies as necessary to ensure that a complete and timely review has been performed.

3.3 Schedule

A work breakdown structure will be used to track project progress. This schedule will be maintained and updated by the Systems Integrator contractor. As the systems integration process creates additional inputs, the schedule will be revised.

3.4 Interface Control Plan Guidelines

Interfaces are the relationships among system components in which the components share, provide, or exchange data. Interface design shall include both interfaces among major components and their interfaces with external entities such as regional hubs, subsystems, operators, and general public users.

A unique Project-specific identifier shall be assigned to each interface. Each interfacing entity (system, configuration item, user, etc.) shall be identified by name, version, and documentation references, as applicable.

This identification shall also state which entities have fixed interface characteristics (and therefore impose interface requirements on interfacing entities) and which are being developed or modified (thus having interface requirements imposed on them).

One or more interface diagrams shall be provided, as applicable, to depict the interface.

For each interface, the description shall include, as applicable, the following with more details in the Interface Control Plan provided by the Contractor for the project.

- Priority assigned to the interface by the interfacing identities
- Type of interface (such as real-time data transfer, storage-and-retrieval of data, etc.)
- Characteristics of individual data elements that the interfacing entities will provide, store, send, access, receive, etc.

- Characteristics of data assemblies (records, messages, files, arrays, displays, reports, etc.) that the interfacing entities will provide, store, send, access, receive, etc.
- Characteristics of communication methods that the interfacing entities will use for the interface
- Characteristics of protocols that the interfacing entities will use for the interface
- Other characteristics, such as physical compatibility of the interfacing entities (dimensions, tolerance, loads, voltages, plug compatibility, etc.)

An interface control requirements document will be developed. This document will recommend:

- The proposed communication protocol standards to be utilized for interfacing field elements, subsystems and systems
- Both the hardware and software interface standards to be followed. Potential interface control standards include:
    - Between the traffic signal control system and the CCTV cameras, IMS, TBS, ADMS, VDS and other traffic control systems (i.e. those associated with the Smart Corridor-other cities and Caltrans ATMS)
    - Between the Caltrans ATMS (freeway management system at the D4 TMC) and the CCTV cameras, IMS, TBS, ADMS, VDS and other traffic control systems (i.e. those associated with the Smart Corridor-other cities and Caltrans ATMS)

3.5 Technical Review Plan

The most common outputs of the systems engineering process are documents, and ensuring that they accurately reflect the input of stakeholders is a critical component of the systems engineering management plan. For this project, all documents, whether developed by consultants, agencies, or third parties, should be reviewed by representatives of both the owning agency and the operating agency. This will help ensure that the final system will be functional and effective.

All comments received are to be tracked. If, during the review process, conflicting comments are made by various parties, the document originator will attempt to resolve them by working with each commenter individually. If this process does not take place reasonably quickly, or a solution does not appear to be simple and straightforward, then a meeting will be scheduled between all affected parties with the purpose of resolving the conflict.

During system implementation, a formal review process will be necessary that requires the following:

- All comments to be in writing

- All comments are to be on a comment review form
- Resolution of all comments are to be in writing
- A formal resolution conflict process is to be established with resolution first being attempted by technical staff. If that is not successful, the item in question is to be directed to a steering committee composed of senior stakeholders.

3.6 Integration Plan

System integration will be a joint effort of Caltrans, C/CAG, the Construction Contractors, the System Integrator Contractor, and the Traffic Control System Contractor and the BAVU Contractor. Caltrans District 4 will serve as the overall System Integrator and is responsible for leading these efforts and for successful integration of the various components of the San Mateo Smart Corridor Project. The System Integrator Contractor will support Caltrans District 4 in this effort and develop a System Integration Plan specifically directed towards this project.

By following the Integration Plan (SIP), the following actions will result:

- Discrepancies and errors are detected and corrected as early as possible in the Project life cycle.
- Equipment and software quality and reliability is enhanced.
- Management visibility into the equipment development and software coordination is improved.
- Proposed changes to the Project and consequences of the changes can be quickly assessed.
- Project risk, cost and schedule are reduced.
- Testing tasks will be performed in parallel with the development of equipment and coordination of software.

System integration will involve the use of a building block approach starting with elements combined into components which are then combined into subsystems and thence into a system. At each stage, testing will occur.

<u>Testing Methodology</u> - All system configuration items will undergo and successfully pass appropriate testing before it is released. Testing will include subsystem testing and system testing. Pre-installation testing relates to tests of all material and equipment in a test environment prior to delivery to the Project Site. Equipment that is provided by Caltrans will undergo pre-installation testing/bench testing by Caltrans.

The initial testing will consist of tests on the individual subsystems. Within a given subsystem, the individual field elements (i.e., an ADMS) will first undergo manufacturer testing. Upon delivery to the project (or to Caltrans in the case of Caltrans-supplied equipment), the item will be subject to bench testing. This will be followed by field testing at the local cabinet followed by testing at the local TMC (if applicable), the SMCHub and the D4 TMC. The TMC/Hub testing will involve end-to-end testing of the various ITS field elements where the project software is used to monitor and control the specific field device. Following successful completion of the individual subsystems, testing will occur per the system acceptance test plan to be developed at a later date.

Testing of the subsystems is dependent on the status of the field installations. However, before end-to-end testing of a subsystem can occur, the communications subsystem will need to first be successfully tested.

Testing will be documented at all stages with pass/fail/comments.

Testing will be performed by the System Integrator and Construction Contractor. Manufacturer staff may be required at the discretion of the project engineer.

Testing personnel shall have a skill set suitable for the particular testing environment.

Failures will be classified as major or minor.

A major failure or a predetermined number of minor failures will be sufficient to either pause or restart the test from the beginning.

Integration will take place in phases. These phases are geographically based. As each phase becomes ready for integration, it will first be tested as a stand-alone system before testing as part of the existing system.

Testing equipment to be utilized will include oscilloscopes, OTDR, voltmeters and other test equipment appropriate to the application. Inputs to the item being tested may be simulated, historical data or real time data.

System testing and design covers the integration testing which is required to validate the operational performance of equipment and software. For the Project, at least for the initial phase, there is expected to be little or no software creation or hardware development. To reduce project costs and risk, all software and hardware scheduled to be used is commercial-off-the-shelf (COTS) applications for at least the initial phase of the Project. This may change for subsequent phases.

Testing will be performed to validate the functionality of the field devices. This functionality will be end-to-end and will show that each device can be controlled and monitored by the local and regional TMCs and eventually the Caltrans ATMS. The exact testing to be performed will be detailed in the individual device acceptance test plans and in the system acceptance test plan. If a malfunction is determined, the responsibility for correcting that malfunction will rest with the party responsible for where the malfunction is occurring (for example, if a camera is not providing an image and it is determined the camera is at fault, the installation contractor will fix the camera; if it is determined there is a problem with the communications lines between the Millbrae BART station and the D4 TMC, then the responsibility is Caltrans'.)

3.7 Verification Plan Guidelines

Acceptance testing for the Project will consist of a variety of tests ranging from tests at the factory on the proposed equipment through system acceptance testing.

Acceptance testing will be based on a matrix that is a function of the requirements, specifications, implementation, and the procedures to ensure that all requirements are tested. An overview is provided below with more details in the Detailed Design Requirements Test Plan. The Detailed Design Requirement Test Plan will include further definition of the test environment, input source/output, method of test, and traceability of a test to the requirements.

<u>Factory tests</u> – As part of the Project, a variety of equipment/material will be required. To ensure this equipment/material is suitable for this project and meets the specifications, it will be necessary that tests be performed at the factory where the equipment/material is manufactured. These tests will range from compliance with environmental requirements (i.e., the operating and storage temperature ranges) to the loss per meter in fiber optic cabling.

<u>Delivery tests</u> – Upon delivery of material to the selected project site, various tests will need to be performed. As a minimum, these tests will be to compare what was ordered with what was delivered and what was specified. Additionally, other tests such as noise loss of fiber optic cable on the reel will be required.

<u>Bench tests</u> – Following delivery testing, it is imperative that additional testing be performed in the shop before placement of the components in the field. This testing will range from simply powering up the component to establishing a mini-network in the shop to demonstrate receipt and transmission of messages as well as compatibility of the various components. Components such as modems will need to be tested to ensure they can transmit data and video and they can be individually addressed.

<u>Unit tests</u> – Unit testing will involve installations at the D4 TMC, at the IT server location, in the field and at remote locations as applicable. Components will need to be connected to the equipment in the cabinet/equipment at their respective locations and tests performed ranging from powering up to receipt/transmission of messages from the connected equipment.

<u>Subsystem tests</u> - Subsystems to be tested include CCTV cameras, VDS, IMS, TBS, ADMS, and traffic signals. However, to do subsystem testing, it will be necessary to first have the communications subsystem in place with a connection provided between the various locations. These communication links will need to be individually tested before connection to the transceivers or other communication devices. Recommended testing shall as be as per the Caltrans Fiber Optic Testing Guidelines (or equivalent). With the verification that the communication links are continuous (i.e., able to transmit a signal in both directions), testing of the subsystem can occur. This will involve sending signals from the field to the D4 TMC and in the reverse direction. Faults will be intentionally introduced. The installed subsystems shall be inspected and tested to validate neat cable placement, cable markings and unit installation in

accordance with manufacturer's installation recommendations. Functional test shall be conducted for the subsystems to ensure that the subsystems perform the functions as a standalone system.

System tests - Once the various subsystems have been tested individually, a system acceptance test will need to be performed to ensure all components (existing and proposed) work together. This will involve end to end testing of all linkages. The testing initially consists of testing the functionality of the components by comparing it to the specifications. A traceability matrix is to be developed to aid in this process. Once the functionality of all the subsystems have been successfully tested, the communications subsystem will undergo an acceptance test period. This testing is typically performed over a 30- to 90-day period with rigid requirements that delineate between minor failures and major failures.

Test plans will be developed by System Integrator to verify the system provided meets the requirements of the specifications.

3.8 Deployment Plan

The deployment of the ITS elements for the San Mateo Smart Corridor Project will be based on the following requirements:

- Organization:
    - Caltrans will be the lead technical entity.
    - C/CAG will provide administrative and technical support to Caltrans.
    - C/CAG will be the contracting agency.
    - Consultants will be used as necessary for design functions, technical assistance during implementation, assistance with review of documentation and assistance during testing
    - Each Contractor will have responsibility for provision, implementation, integration and testing of its portion of the proposed system.
    - A System Integrator (Caltrans) with support from system integration contractor will have overall responsibility to coordinate the work of multiple Contractors and integrate and test the entire Smart Corridor system.
- The Project will follow a staged implementation:
    - The pilot implementation will be in the City of San Mateo – this project was completed in early 2013
    - Following successful implementation of the pilot project, the next implementation will be phases as discussed in Section 2 of this document.
- Procurement

- The initial procurement will be for the pilot implementation followed by phases as discussed in Section 2 of this document. Equipment provided by Caltrans will be uniquely identified and provided in a timely manner
- All procurements should be competitive.
- The option shall exist for a local agency to provide equipment to the selected integration and installation contractor(s).
- Maximum use shall be made of multi-agency procurements.
- The procurement process shall follow the requirements of the local agencies, Caltrans and the funding agencies.
- C/CAG shall lead the procurement effort with assistance from other affected agencies.
- Non-proprietary components are to be given priority over proprietary hardware components.
- For hardware and software development and procurement, minimum or essential requirements that are not controlled by performance characteristics, interface requirements or referenced documents will be specified. They will include appropriate design standards, requirements governing the use or selection of materials, parts and processes, interchangeability requirements, safety requirements, and the like.
- Special attention will be directed to prevent unnecessary use of materials that may impact the schedule or the implementation of the project.
- Where possible, hardware components are to be interchangeable and replaceable.

- Implementation
  - The System Integrator Contractor shall provide a deployment plan/schedule for review by Caltrans/ C/CAG. This deployment plan/schedule is to be updated at least monthly.
  - The System Integrator is to provide 24 hours' notice before entering a cabinet unless it is an emergency.
  - The System Integrator shall integrate the system according to the approved System Integration Plan. This is to involve a building block approach.
  - Training on the system is to be provided before system acceptance testing.
  - The System Integrator shall provide lead technical staff with at least 5 years of experience in the implementation of similar systems.

- The System Integrator shall provide a cutover plan for approval. This cutover plan shall provide for a near seamless transition from existing operations to the proposed system with minimal impact on operations.
- If a new feature is added or desired to be added to the system and it is determined this feature has system-wide applicability, it should first be installed and tested in the existing system.
- The System Integrator is responsible for obtaining and complying with all permits.

- Maintenance and Operations
  - Once the Contractor accesses a cabinet, he is then responsible for maintenance of that cabinet and associated equipment until system acceptance.
  - New equipment provided by a local agency will be maintained by the local agency to the extent the local agency will be viewed as a manufacturer. The Contractor will be responsible for identifying malfunctions and replacement of equipment.
  - Spare equipment is to be stockpiled locally and provided in a timely manner.
  - Operation of equipment until system acceptance shall remain with the entity responsible before system implementation

3.9 Operations and Maintenance Plan

New equipment, the communications network and the system hardware and software provided by the Project and outside State Right-of-Way will be owned by the local agency where it is located and maintained by the local agency. Following system acceptance, C/CAG will be responsible for arranging for maintenance of this equipment, the communications network and system hardware and software.

Equipment provided by another public entity shall be owned and maintained by the public entities following system acceptance. Modifications of this equipment will be owned by the public entity and maintained by C/CAG.

The owner of the equipment shall be responsible for maintaining a suitable supply of spares that can be provided in a timely manner.

Maintenance of equipment shall be provided in accordance with the manufacturer's recommendations.

Operations and maintenance shall be in accordance with the Operations and Maintenance Plan.

A Memorandum of Understanding (MOU) has been signed between the various public entities on this Project that contains the requirements in this section.

The System Integrator Contractor shall provide an Operations and Maintenance (O&M) Plan for all equipment, hardware and software he provides or modifies. This plan shall conform to the following:

- The O&M Plan for the project will be reviewed and approved by the stakeholders.
- The O&M Plan shall clearly explain the methods that will be used to effectively operate and maintain the system in consistent with other contract document requirements.
- The O&M Plan will be followed after the warranty period.
- The stakeholders will closely monitor the O&M effort to ensure that it is being performed correctly.
- A system activity log will be kept, which will include system deficiency report, user feedback, and system repair record on all components, subsystems and the system as a whole.
- Maintenance shall be carried out in a way that minimizes the interruption to normal system operations. Any maintenance activities that cause major interruption shall be discussed with and approved by the affected agencies prior to implementation.
- All system support and maintenance activities shall be documented.
- System documentation that is affected by maintenance and enhancement activities shall be periodically updated.
- The O&M Plan shall include a user manual, a policy manual and a maintenance manual.
- The O&M Plan shall include preventive maintenance as well as periodic maintenance.
- Special hardware and software required to maintain the system, subsystems and the components shall be identified.

3.10 Training Plan

The System Integrator shall submit a training plan for approval which meets the following requirements:

- As equipment is installed and upgraded on this project, training in operation as well as maintenance and repair will be required. Wherever possible, this training should include hands-on experience, either in the field, at the San Mateo Hub or in the Caltrans TMC, and be provided by the equipment manufacturer or other qualified personnel.

- Classroom training should be provided in the theory and design of various subsystems throughout the corridor.
- An outline shall be provided for approval prior to scheduling training classes.
- Training materials shall be provided for approval prior to initiation of training.
- At least one location of each type of field equipment shall be in place prior to initiating training.
- Training shall be oriented to the audience (i.e., administrators, operators, maintenance personnel).
- All training should include testing of the attendees at the end of each session to verify necessary knowledge and skill levels.
- Written manuals should be provided as part of each training workshop.
- As new functionality or hardware is added to the system, training on these new items shall be provided in a timely manner.
- Training must be satisfactorily completed prior to assumption of maintenance responsibilities.

3.11 Configuration Management Plan

Configuration management applies to all aspects of system design, development, implementation, operation and maintenance.

Configuration control will be maintained by a change control board (CCB), which is defined below. The CCB will enforce rigorous control and tracking procedures of the system changes. The change control system will ensure that any change made to a system, subsystem or component will be analyzed before change implementation and changes must be tested before being incorporated.

The CCB shall consist of technical representatives from the stakeholders (Caltrans, C/CAG, and non-voting representation by the System Integrator).

The general responsibilities of the Change Control Board shall include, but are not limited to:

- Establishment and maintenance of engineering baselines
- Provision of configuration requirements and control
- Configuration identification and assignment of version numbers
- Participation in formal audits and reviews
- Tracking the status of items under configuration management

- Establishment of periodic milestones and configuration reviews (including periodic integration testing)
- Approval and tracking of change requests and defect reports

The System Integrator shall submit a configuration management plan for approval by Caltrans and C/CAG.

Configuration identification shall identify each critical component, including software unit, documentation, and other supporting information that is to be put under the configuration control. Any such component is termed a Configuration Item (CI). Configuration identification also consists of defining baselines and releases that are time-phased to the development schedules.

Each CI shall be assigned a unique identification. For example, a document may be assigned the number 1300 and the name *System Review Procedures*. The document will be referred to as Document #1300. Version control shall maintain individual versions of the CI. The CI and version control shall be maintained in each document.

Major versions of the CI shall be recorded as a decimal extension to the CI unique number, as in Document #1300.01. Minor versions shall be indicated by a letter extension (Document #1300.01A). Temporary versions shall be indicated, where necessary, by a date (Document #1300.02C – 04/05/1999).

Major versions of CIs shall be established when the CI are accepted by the CCB and enter a baseline. Minor versions of CI shall be established as necessary to indicate a new level of available functionality or information. Temporary versions shall be used by individual development teams where desired.

Change control (CC) is intended to assure a disciplined process for handling problems and changes of CIs. Any change to any CI under CCB control shall go through change control. Change control starts from a change request originated by a developer, user, Independent V&V tester, or one of the stakeholders. This request shall include the description of the problem (if any), the proposed change, and the impact of the change (both cost and benefit) from the point of view of the party proposing the change. If deemed necessary, the CCB shall identify parties that might be affected by the change and distribute the change request for their review. CCB members will then combine their assessments and prioritize the change request. The CCB may decide to accept, reject, or defer the change request. If a change request is accepted, the change tasks will be allocated. The CCB shall notify all concerned parties about its decision. The originator shall document this request in a Change Request Form (CRF) and submit this request to the CCB. The CCB shall sign it to indicate its decision. If a change request is approved, the change implementers shall implement the change proposed in the CRF. The implementation of changes shall follow the regular CI development procedures. Successful testing must be conducted before the CI is released to the CCB to be put under CCB control.

A change request tracking tool shall be evaluated and selected prior to the Initial Build. This tool will be used by the development team to track the status of each CI change including:

- Establishment and maintenance of engineering baselines
- Provision of configuration requirements and control
- Configuration identification and assignment of version numbers
- Participation in formal audits and reviews
- Track the status of items under configuration management
- Establishment of periodic milestones and configuration reviews (including periodic integration testing)

Each version or stage will consist of the following:

- A description of the functionality to be met by each of the subsystems for this version/baseline (i.e., the development goals for the baseline)
- A definition of specific CI within each subsystem whose configurations will be tracked according to the requirements of the System Development Plan (SDP)
- A description of the integrated functionality to be accomplished during baseline integration
- A series of test cases and functionality assertions which must be met by each CI and each subsystem before the baseline integration begins
- A series of test cases and functionality assertions which must be met by the integrated baseline
- A development schedule for each CI and subsystem
- A development schedule for baseline integration

3.12 Risk Management Plan

Potential project risks and the associated mitigation measures are identified in the following table.

Table 8 – Potential Project Risks and Proposed Mitigation

Potential Project Risk	Proposed Mitigation
Funding will not be available when needed	C/CAG and SMCTA to closely monitor
Custom software development will delay the project or require additional funding	The project specifications are to maximize use of off the shelf components. This will be done by thoroughly reviewing the potential

	applicable systems
Unexpected field problems such as damaged conduits	Maintain a contingency fund
Unavailability of staff	Commit staff to this project
Unavailability of public agency supplied equipment including spares	Stockpile needed equipment prior to implementation
Impact of other construction activities	Inform owners of equipment/facilities in the right of way of this project
Delays in reviewing contractor submissions	Commit to the approved schedule
Standardized equipment incompatible	Be prepared to replace with compatible equipment
Communications issues	Resolve as they occur

3.13 Documentation

Project documentation control includes the processes to ensure that the Project is administered in conformance with the contract requirements. A solid and efficient document control system to administer Project records will ensure that the work is constructed in accordance with the contract requirements.

Documents shall be developed that describe the responsibilities and requirements for the identification, preparation, and maintenance of records that furnish documentary evidence of the process undertaken, the design of the system, the implementation of the system, and the operation and maintenance of the system. The term "records" used throughout this section refers to records attesting to the achievement of the requirements that are generated during the various phases of this project.

Records will be legible, identifiable, and retrievable. These records will be protected against damage, deterioration, or loss. Requirements and responsibilities for record transmittal, distribution, retention, maintenance, disposition, and organizational responsibilities will be identified. A record is defined as a completed document that furnishes evidence of the quality of items and/or activities affecting quality. A records retention and distribution system will be established by C/CAG and Caltrans. The scope of the records retention and distribution system will be described in instructions and procedures.

Records will be indexed. The indexing system will include, as a minimum, record retention times and the location of the record within the record system. The records and/or indexing system will provide sufficient information to permit prompt retrieval, and identification between the record and the items or activities to which it applies.

Corrections to records will be controlled. Controls will provide for appropriate review or approval by the originating organization. All corrections will include the date and the identification of the person authorized to issue the correction.

Previously developed records shall be updated when major changes are made and accepted in related documentation

Records shall be subject to configuration management.

Original records shall be numbered as follows:

- Systems Engineering Management Plan (10000 series)
- Functional Requirements (12000 series)
- High-Level Requirements (13000 series)
- Detailed Design Requirements Document (13500 series)
- Interface Control Requirements (14000 series)
- Configuration Management Plan (15000 series)
- Verification Plan (16000 series)
- Verification Procedures (16500 series)
- Deployment Plan (17000 series)
- Training Plan (18000 series)
- Quality Assurance/Quality Control Plan (19000 series)
- Design Documents including PS&E (numbered per agency requirements) *(to be developed by Caltrans or its designate)*
- Integration Plan (20000 series)
- Test Plans (22000 series)
- Operations and Maintenance Policy Manual (23000 series)

4.0 Systems Engineering Process

The most significant objective of the system engineering process is to ensure that the resulting design meets the technical performance requirements of the ITS system and field elements throughout the project lifecycle. To meet this objective the systems engineering process is utilized to minimize changes to the detailed design once it has been completed.

4.1 System Engineering Planning Process

The systems engineering planning process is an interdisciplinary approach that helps to enable the realization of successful systems. It focuses on defining customer needs and required functionality early in the development cycle, documenting requirements and proceeding with design synthesis and system validation while considering the complete problem:

- Operations
- Performance
- Test
- Manufacturing
- Cost & Schedule
- Training and Support
- Disposal

Systems engineering integrates all the disciplines and specialty groups into a team effort forming a structured development process that proceeds from concept to production to operation. Systems engineering considers both the business and the technical needs of all customers with the goal of providing a quality product that meets the user needs.

The SE process ("the process") is used to identify the project's needs and constraints and lay out the activities, resources, budget, and timeline for the project. A critical part of the process is to build consensus among the stakeholders of the project. The process should be applicable at all stages of a project, from initial system planning through final operations and maintenance of the system.

FHWA Federal Rule 940, Intelligent Transportation Systems Architecture and Standards, which implements Section 5206 (e) of the Transportation Equity Act of the 21st Century (TEA-21), requires agencies implementing projects with ITS elements utilizing federal funds to develop regional architectures and adopt a SE approach for project deployments in order to qualify for ITS grants.

The process shall be followed for the San Mateo County Smart Corridors Program.

The following table illustrates the relationship between the various processes of the SE process and Rule 940.

Table 3 – Systems Engineering and Rule 940

Systems Engineering Process Step(s)	Corresponding *Rule 940* Requirements
Concept of Operations	• Identification of participating agencies' roles and responsibilities • Procedures (and resources) necessary for operations and management of the system
Requirements: High-Level and Detailed	• Requirements definition
Design: High-Level and Detailed	• Identification of portions of the regional ITS architecture being implemented • Analysis of alternative system configurations and technology options to meet requirements • Procurement options • Identification of applicable ITS standards and testing procedures

The initial version of this project's systems engineering documents were prepared using the guidelines in the "Systems Engineering Guidebook for ITS", version 2.0 dated January 7, 2007 published by the Federal Highway Administration/California Division and Caltrans/Division of Research and Innovation. Subsequent versions of these documents will be updated to closely match "Systems Engineering Guidebook for ITS", version 3.0 dated November 2009 as much as possible. .

The process can be summarized in a "V" diagram (see Figure 2 below). The first phase of the process involves concept exploration and identification of regional architecture requirements. The next phase includes developing a SEMP (this document) and a Concept of Operations (ConOps) for the proposed system (to be updated as part of this Project by Systems Integrator). Once those are completed, the system requirements (both functional and performance) are able to be determined, and a matrix is developed that ties all requirements to their origin in the ConOps. This matrix will later be used as the framework for the System Verification plan. This is followed by high-level design, which develops requirements for subsystems and begins to detail the architecture of the system. The next phase is detailed design, which draws from all the previous documents to identify each piece of the system and produce plans for construction. During each stage of construction and installation, the process is used to test, validate, and accept systems and subsystems to ensure that the final product will meet or exceed the expectations written out during the planning and design phases.

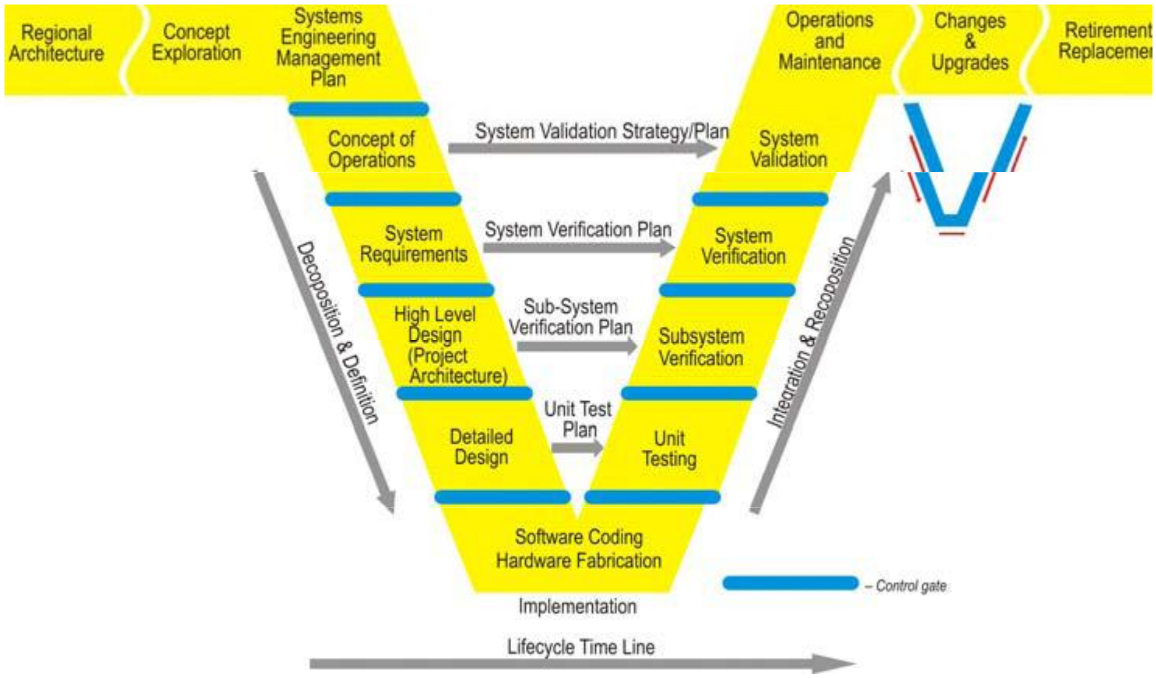

Figure 2 – System Engineering“V” Diagram

At each phase of the process, applicable documents will be developed. A typical project would include but not be limited to the following (not necessarily in order):

- Regional System Architecture
- Concept of Operations
- System Engineering Management Plan
- Functional Requirements
- High-Level Requirements
- Detailed Design Requirements
- Interface Control Requirements
- Configuration Management Plan
- Deployment Plan
- Design Documents including PS&E
- System Integration Plan
- Individual Test Plans
- System Acceptance Test Plan
- Verification Plans

- Test Plan Results
- Maintenance Plan
- Operations Plan

For this project, requirements are broken into several documents:

- Functional requirements
- High-level requirements
- Detailed design requirements
- Interface control requirements

Requirements focus on “what” the system must do, not “how” the system does it. A requirements analysis includes:

- Functions
- Expected outcomes
- Definition of expected interfaces
- Performance objectives

The requirements defined should be based on the ConOps developed previously and any revisions made in this phase of the project. When considered against the requirements of Federal Rule 940, this step of the process relates to the requirements definition aspect of the systems engineering analysis.

Requirements will be traced in a matrix from the ConOps through the Requirements to the Test Plans.

Many documents (such as the SEMP) will be living documents, subject to revision as the process moves forward. The documents serve to provide connection between the various phases of the project and a framework from which to build a well-functioning system that brings benefits to all stakeholders and end users.

4.2 Regional System Architecture

The proposed system shall be compatible with the Bay Area Regional Architecture.

The proposed system shall use the Bay Area C2C communications protocol between systems.

It is not necessary that the interface protocol between components in a system or subsystem be compatible with like components in another system or subsystem.

4.3 Requirements Documentation

The functional requirements will be based on:

- San Mateo County Arterial Route for Traffic Incident Guide, February 2009
- The San Mateo County Smart Corridors Program Concept of Operations, October 2008
- Multiple traffic signal systems along El Camino Real Inclusion of CCTV cameras, trail blazer signs, ADMS and vehicle detection systems along El Camino Real and other proposed alternate routes
- Signal control hierarchy/strategies for remote signal timing and control (signal operational strategies will be provided by Caltrans)
- Termination of the Smart Corridor communications backbone at the Millbrae BART station
- Identification of the functionality of the proposed systems (communications, traffic signal systems, CCTV, trail blazer and vehicle detection)
- Identification of the functionality desired between the existing Caltrans ATMS and the proposed systems
- The functional requirements will be technical in nature and not operational or institutional.
- The functional requirements shall be traced to the ConOps where possible
- The functional requirements will be further detailed in future documents
- Each requirement will have a method of verification
- Constraints resulting from technology, standards or policies

The high-level requirements will be based on the following:

- Functional requirements developed previously
- System requirements will be of the following types:
  - Functional in nature (what the system shall do)
  - Performance (how well the system and its components will perform)
  - Interface (definition of the interfaces to other systems or components or users)
  - Data (data elements)
  - Non-functional (safety, reliability, environmental)

- Enabling requirements (production, development, testing, training, support, deployment, etc.)
- Constraints imposed

The detailed design requirements will be based on the following;

- High-level requirements previously developed
- Identification of the system architecture and its associated subsystems (this will include notation of its integration with the Regional Architecture)
- Identification of the logical architecture
- Further definition of the data, performance measures and interface requirements
- Tracing the detailed design requirements to the high-level requirements to the functional requirements and the ConOps
- Evaluation of alternative communication systems along El Camino Real and other proposed alternate routes (this effort will involve investigation of alternative protocols, alternative physical interfaces, alternative recommended equipment and the use of interim communication technologies if needed)

4.4 Standards

The National Transportation Communications for ITS Protocol (NTCIP) defines a family of general-purpose communications protocols and transportation-specific data dictionaries/message sets that support most types of computer systems and field devices used in transportation management. Applications for NTCIP are generally divided into two categories: center-to-field (C2F) and center-to-center (C2C). C2F normally involves devices at the roadside, communicating with management software on the central computer. C2C applications usually involve computer-to-computer communications where the computers can be in the same room, in management centers operated by adjacent agencies, or across the county. Some of the data transfers involved in ITS operational uses have special needs that are the subject of other standards not covered under NTCIP. NTCIP standards can be classified into: primary, supporting and base standards and protocols.

Equipment compatibility will be confirmed in several ways:

- Specifying the required compatibility with the D4 TMC
- Specifying equipment that is either similar or identical to that which has already been integrated with the D4 TMC
- Performing verification and validation testing on ITS components

- Performing a System Acceptance Test

The following table lists reference documents to be followed in the design, implementation, testing, operation and maintenance of the proposed system.

Table 4 – Design Reference Documents

Document	Reference Source
Standard for Application and Management of the Systems Engineering Process, IEEE Std 1220-2005,	The Institute of Electrical and Electronics Engineers, Inc.
Guide for Information Technology – System Definition – Concept of Operations (ConOps) Document, IEEE Std 1362-1998, March 19, 1998	The Institute of Electrical and Electronics Engineers, Inc.
System Life Cycle Processes, ISO/IEC Standard 15288, October 2002	ISO Central Secretariat, International Organization for Standardization (ISO)
Quality Management System Guidelines for Configuration Management Revision 3,ISO 10007, June 15, 2003	ISO Central Secretariat, International Organization for Standardization (ISO)
Quality Management System Requirements, ISO 9001, December 15, 2000	ISO Central Secretariat, International Organization for Standardization (ISO)
Transportation Electrical Equipment Specifications (TEES) for Model 334 CCTV housing and mounting cage.	Caltrans
Caltrans "Standards Specifications" dated 2010	Caltrans
Caltrans "Standard Plans" dated 2010	Caltrans
Caltrans Transportation Electrical Equipment Specifications (TEES), March 2009	Caltrans
IEEE 1220-2005, Institute of Electrical and Electronic Engineers (IEEE), Standard for Application and Management of the Systems Engineering Process, 2005	IEEE
EIA 632, Electronics Industries Association (EIA), Processes for Engineering a System, Jan. 1999	EIA
EIA/IS 632, Systems Engineering, Interim Standard, Sep. 20, 1994	EIA
EIA-359 (ANSI C83.1), Colors for Color Identification and Coding, Jul. 1998	EIA

Table 4 – Design Reference Documents

Document	Reference Source
EIA-359-1 Addendum 1 to EIA-359, Electronics Industries Association (EIA), Special Colors (for Color Identification and Coding), Jul. 1998	EIA
TIA/EIA-456, Telecommunications Industries Association / Electronics Industries Association (TIA/EIA), Test Procedure for Fiber Optic Fibers, Cables, Transducers, Sensors, Connecting and Terminating Devices, and Other Fiber Optic Components, Oct. 1998	TIA/EIA
TIA/EIA-568 SET Commercial Building Telecommunications Cabling Standards Set: Part 1 – General Requirements; Part 2 – Balanced Twisted Pair Cabling; Part 3 – Optical Fiber Cabling Components Standard, June 2002	TIA/EIA
TIA/EIA-569, Commercial Buildings Standard for Telecommunications Pathways and Spaces, Dec. 2001	TIA/EIA
TIA/EIA-598, Optical Fiber Cable Color Coding (ref. Munsell 10100, EIA SP 3555), Dec. 2001	TIA/EIA
TIA/EIA-606, Administration Standard for the Commercial Telecommunications Infrastructure	TIA/EIA
TIA/EIA-758 Customer-Owned Outside Plant Telecommunications Cabling Standard, Apr. 1999	TIA/EIA

Note: Above references to be confirmed during the design phase.

The system shall utilize the interface standards as noted in the following table.

Table 5 – Device Interfaces and Standards

Device	Physical Interface	Interface Standard	Protocol/Description
Model 2070 Controllers to Protocol OTR/SHR	C2-S Connector	EIA-232	NTCIP CMS
CCTV Camera Control Protocol to VOTR	DE-9 Connector	TIA-574	Specified CCR
CCTV Camera Video Out to Video VOTR	BNC Connector/ Coaxial Cable	NTSC	Color Full Motion
CMS to Modem	DB-25 Connector	EIA-232	
CMS to OTR/SHR	DB-25 Connector	EIA-232	Caltrans Protocol
Node Processor to Backbone	RJ-45	IEEE 802.3 10Base-T	Ethernet
Node Processor to (see OTR/SHR above)	DB-25 Connector	EIA-232	Device Specific
Node to TMC/TOC (TDM)	SC Connector, Single Mode Fiber	Point-to-Point	DS-1
Video switch/ Video Demux	BNC Connector Coaxial Cable	NTSC	Color Full Motion

5.0 Transitioning Critical Technologies

Critical technologies are those technologies which, if not used, prevent the system from meeting its goals/objectives and providing the functionality required. There are no backups to critical technologies. With this definition, all technologies in the proposed system are critical.

6.0 Integration of the System

As part of the System Integrator Support project, the System Integrator support contractor will create a detailed Integration Plan that complies with FHWA guidelines and, more importantly, clearly explains the roles and responsibilities of each participant on a per task basis. The Integration Plan will be divided into the sections listed below.

- **Purpose of the Document** – A brief statement of the Integration Plan's purpose.
- **Scope of Project** – A brief description of the planned project.
- **Integration Strategy** – This section will explain the high level plan for integration and why the plan is structured the way it is. A project of this nature is bound to have several constraints or conditions that must be met in order to be deployed successfully. These constraints can take the form of technical capabilities or preconditions, production/development schedule of other systems that are needed to support the San Mateo system and contractual limitations placed on other stakeholders. These will all be discussed and explained in detail at the outset so all parties fully understand the overall strategy.
- **Phased Integration** – A separate section will be provided for each integration phase. This section will define and explain each step in the integration process. Each step will identify:
    - The activity location.
    - The hardware, software and firmware to be integrated including quantities and part numbers/model numbers.
    - Support equipment (special software, test hardware) needed for this step.
    - All integration activities to be completed before, during and after installation, including integration with on-site and external systems at other sites. Examples of activities performed prior to installation include off-site Ethernet switch and encoder hardware configuration and stand-alone testing.
    - A description of the verification activities that occur after this integration step.
    - The responsible parties for each activity in the integration step.
    - The schedule for each activity.

7.0 Integration of the Systems Engineering Effort

This project involves integrating the field devices included in the Initial Demonstration Project along with traffic signals, Trailblazer Signs (TBS), CCTV cameras and the supporting communications infrastructure for the eleven local agencies, with implementation being done by the Contractor and Traffic Control System vendor, all under separate contracts. Successfully integrating these elements into a cohesive system with access from Caltrans District 4 and each of the Project Stakeholder’s TMCs will involve coordinating with the following entities at a minimum:

- Public Works Department for 10 cities and one County
- Information Technology Department for 10 cities and one County
- Caltrans District 4 Office of Electrical Systems
- Caltrans District 4 Division of Operations
- Caltrans District 4 Division of Construction
- Caltrans District 4 BAVU System Contractor (ICx)
- Caltrans District 4 ATMS Contractor (Delcan)
- Construction Contractors (3)
- San Mateo County Traffic Signal System, KITS (by KHA)
- Hardware providers (CCTV cameras, TBS, ADMS, vehicle detection, switches, routers) procured by the Contractor or Iteris as part of the System Integrator support project.

As mentioned in the “Integration of the System” section, the System Integrator will create a detailed Integration Plan that addresses the integration of the multi-disciplinary organizations or teams that will be performing the systems engineering activities.

In addition to developing the Integration Plan, the System Integrator will provide technical support to Caltrans District 4 and other Project Agencies in support of the integration efforts. Iteris will receive technical input and direct oversight from the Project Agencies for all assigned tasks. On a task order basis, the System Integrator will provide support in the areas of configuration, contractor installation assistance and testing of field devices, communications equipment, workstations, servers and head-end equipment.

8.0 Applicable Documents

Relevant documents include:

- FHWA/Caltrans Systems Engineering Guidebook for ITS, version 3.0, November 2009.
- Final Draft ITS Infrastructure Improvement Plan, San Mateo County Alternative Route Plan, January 2008
- Draft Project Report in San Mateo County on US-101 and SR-82 from I-380 to the Santa Clara County Line, San Mateo County Smart Corridors, EA 4A9200, October 2008
- Project Study Report to Request Programming in the STIP for Phase 1of the San Mateo County Smart Corridors, March 2008
- San Mateo County Smart Corridors Projects Traffic Light Synchronization Program Funding Application March 2008
- San Mateo County Arterial Route for Traffic Incident Guide, June 2009
- San Mateo County Smart Corridors Program Concept of Operations, October 2008, updated September 2009
- Functional Requirements, San Mateo County Smart Corridors Program, version 12000.007, September 2009
- High Level Requirements, San Mateo County Smart Corridors Program, version 13000.003, September 2009
- Detailed Design Requirements, San Mateo County Smart Corridors Program, version 13500.004, September 2009
- Interface Control Requirements, San Mateo County Smart Corridors Program, version 14000.004 September 2009
- Detailed Design Requirements Test Plan, San Mateo County Smart Corridors Program, version 23000.004, September 2009